SCIENTIFIC / TECHNICAL / MANAGEMENT SECTION

1 Introduction

A new generation of large space-based and ground-based telescopes will dominate the next decade of astronomy. Maximizing scientific returns is a priority for observatory operations, because the community must realize maximum scientific returns on their invested capital. Maximizing the returns starts with the first step of planning and developing the observation. The scientist needs to obtain high quality data that meet their scientific objectives while obeying the observatory's operating conditions and using its resources. The majority of high-end ground-based observing and all space-based observing is now done in service-mode, where observations are executed from a pre-scheduled queue. The observing plan must be generated upfront and subsequently transmitted to the observatory. Details that are left unspecified or are ambiguous can produce undesirable results. Misunderstanding or misinterpreting the observing parameters can lead to disappointing observations. For example, even the most sophisticated data analysis system cannot compensate for data taken with too much scattered background light or periods outside the scientific constraints of the program. *Obtaining quality scientific data from either a space-based or ground-based observatory thus requires efficient, informed, and complete observation planning.*

Traditionally, developing well-defined observation programs have required extensive user support including observatory staff, tools, and documentation. In our resource-limited environment, we must consider innovative approaches to user support. In recent years, technological advances such as widespread use of the Internet, multi-platform visual development tools, and overall increases in the power of desktop hardware are allowing for significant improvements in user support tools that can be provided by an observatory. *Intelligent observing proposal development tools with built-in flexibility are now not only feasible, they are essential to achieve sustained cost reductions and significant gains in scientific returns.*

SEA: The First Step Towards a New User-Support Paradigm

Under the direction of the Next Generation Space Telescope (NGST) our team has developed a prototype for a new proposal preparation tools environment, the Scientist's Expert Assistant (SEA). The project leverages on the use of the Internet and the latest developments in software technologies and will be validated using Hubble Space Telescope (HST) in 2000. Two of the SEA modules, the Visual Target Tuner and the Exposure Time Calculator, are so effective that Space Telescope Science Institute (STScI) has already committed to adapting them for operational release by early 2000. Thus far, the SEA has sought to provide users with relatively simple information in an interactive form - visualization of the field-of-view, exposure time information, etc (see http://aaaprod.gsfc.nasa.gov/Sea for further information).

Without adequate planning, documentation, and software tools, astronomers can't make informed decisions - they must either guess at the outcome (sometimes incorrectly) or spend time finding the answer. Observatory staff is often unaware of the scientific implications of small changes to an observing program. This leads to an inefficient, repetitive, time-consuming communication cycle between the observatory staff and the observer. In informal testing, the SEA has already shown that by providing information to the observer up front - when the observer is preparing a proposal - significant cost savings and program improvements are possible.

2 Objectives and Impact

We propose to develop proposal preparation tools that will substantially advance the productivity in the observation planning process. Our goal is to make a substantial leap in the ability of astronomers to evaluate the quality of their observation prior to committing expensive and scarce observatory time and resources. Consistently obtaining high quality data from observations will be the norm. The tools will explore new visual approaches that will allow astronomers to simulate the quality of proposed observations based on known observing parameters, such as target properties (e.g. brightness, spectral energy distribution), instrument setup (e.g., choice of detector gain, dithering, orientation of field-of-view, level of calibration), and observatory conditions (e.g. sky conditions). With these proposed tools, observers can make better and more informed decisions about scientific trade-offs in real-time. They would be able to easily recognize and prevent problems. In addition, we will develop expert rules so that the tools can provide guidance to observer that is impossible with current tools. For example, the tools could automatically suggest orientation angles and positions that would avoid potential detector artifacts and still produce high quality data for a given observing mode.

The process of proposal preparation is very similar across multiple observatories. Therefore, we further propose to develop the proposal preparation tools in an extensible framework, i.e., the architecture of the core class libraries will be such they can be easily adapted to multiple missions or observatories.

Over the last decade, the astronomical community has developed some simulation algorithms. Our thrust in this project is not to re-invent the wheel by rewriting code, but to develop tools with interactive, visual and user friendly interfaces, and to leverage off the decades of robust core algorithms whenever possible. Hence, we will when available/possible, integrate existing astronomical simulation algorithms and models.

Researching new visual approaches to predicting and analyzing the likely scientific value of observations prior to committing observatory resources has potential revolutionary impact on observing proposals. Its impact will be felt across a wide variety of observatories, both within and outside of NASA. The application of interactive, possibly three-dimensional, visual tools to the front-end process of developing observing programs is an entirely new approach. Support from the AISR program is essential because the risk factor in researching and evaluating new and untested approaches is not feasible in the highly resource-constrained, production-driven environment in which all observatories operate.

The scientific and operational impacts of this project include:

?? Facilitation of scientific investigation for observers.

?? Increase in the quality of scientific data returned from each observing mission.

?? Decrease in the effort spent on routine matters by observatory staff.

?? Providing the astronomical community with a suite of tools and utilities that are easily adaptable to multiple observatories.

By giving astronomers tools to visualize their programs in entirely new ways, we envision not simply productivity gains, but the ability to optimize a program both to increase the level of scientific return, and to avoid pitfalls where the quality of an observation does not live up to expectations.

Because of the extensibility of the proposed architecture of the tools, they will be easily available/adaptable to missions/observatories that do not have the financial resources to develop such tools on their own. Realizing the benefits of the proposed proposal preparation tools in an era of declining budgets ("smaller, cheaper, better") requires observatories to leverage the efforts of developers and to re-use software. To achieve the goal of inter-observatory coordination/common interfaces, we first needed to form a common library of re-usable subcomponents that each observatory will use as needed. Our modular set of tools and utilities is a start for such a library. If different observatories have common/similar tools, then astronomers will have an added productivity boost by not having to relearn proposal-planning tools for every observatory.

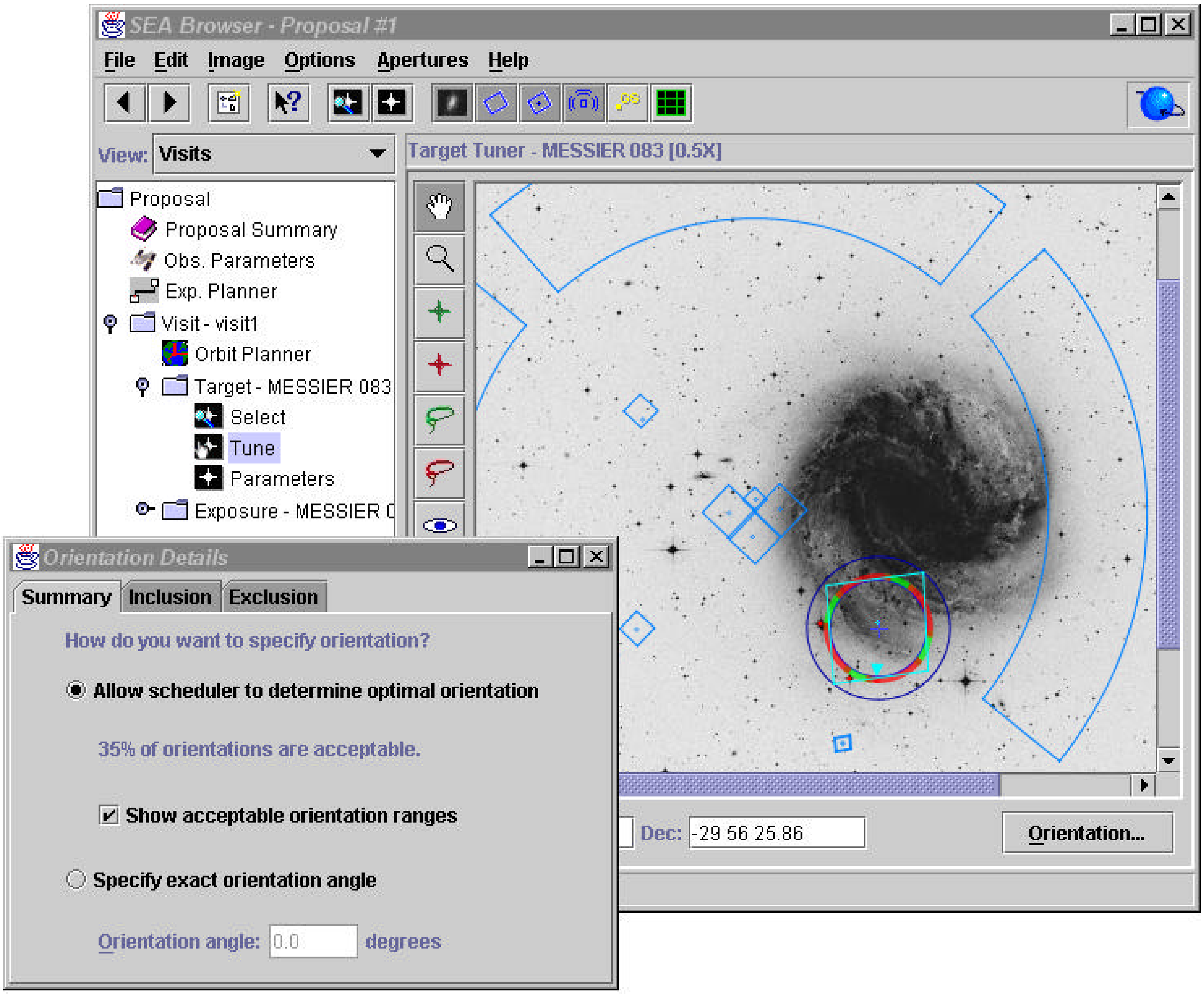
3 Technical Approach

3.1 SEA – Proof of Concept

The Scientist's Expert Assistant (SEA) has been a prototype effort to investigate ways to substantially reduce the effort involved in supporting astronomical observing programs. Initially funded by NGST, a small team of astronomers and computer scientists for STScI and Goddard’s Advanced Architectures and Automation (Code 588) group developed a functional prototype that uses a visual and expert system approach to developing and planning observing programs. The system was developed with HST as a test bed and currently supports several its instruments.

In SEA, users can retrieve and display previously observed images of astronomical targets, overlay any of HST's instrument apertures on the image and by "clicking and dragging" visually define some limited parameters of their observations. For example, the probability of scheduling, because of the choice of a particular aperture orientation can be determined by just rotating the aperture interactively (see Figure 1). A built-in Exposure Time Calculator allows users to graphically visualize the impact of changes in target properties and instrument setups on exposure time and/or signal-to-noise (see Figure 2). In addition, a rudimentary expert assistant can quickly guide new users through the various detector/filter combinations and recommend a combination that fits the users’ scientific needs. SEA has also taken the first steps to integrating documentation with software, providing preliminary user-sensitive help.

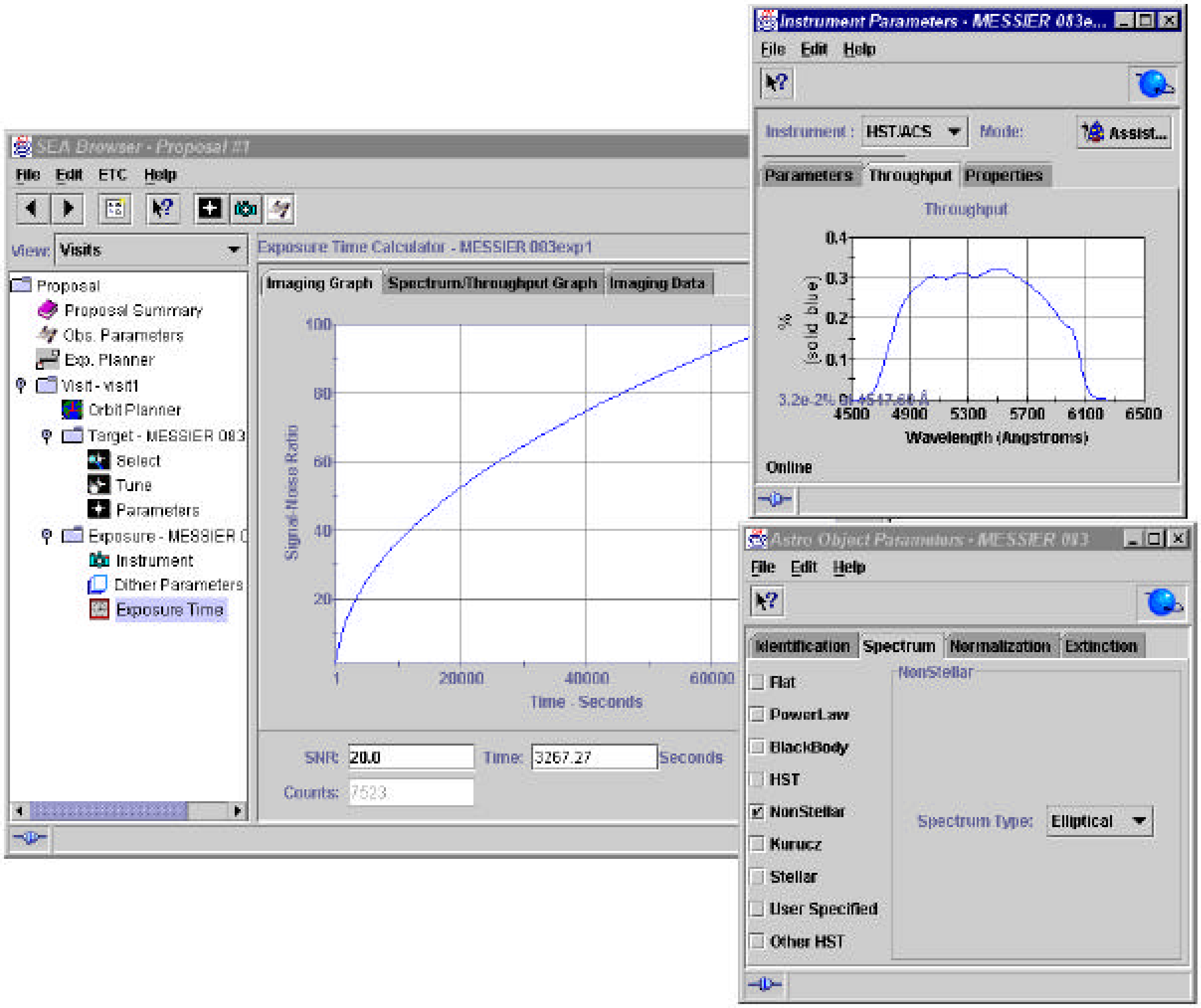
Figure 1 SEA's Visual Target Tuner



SEA is based on a component architecture that shares a common underlying object oriented design and allows the major components to function either as independent modules, or as an integrated whole under the "Proposal Browser." Current modules include a Visual Target Tuner, an Exposure Time Calculator, a Visit Planner, an Orbit Planner, and the integrating Proposal Browser component. By developing the system using the Java programming language, we have a true multi-platform system that operates on Microsoft Windows, Linux and Unix platforms with no modifications.

The technical approach to developing SEA has been an iterative rapid prototyping approach. Informally known "design-a-little-build-a-little-test-a-little," this approach involves iterating through the design/build/test cycle allowing new ideas to be quickly explored, and if promising to

Figure 2 SEA's Exposure Time Calculator



be developed further. If a particular feature does not show effectiveness, it can be abandoned before excessive resources have been invested.

At this time, SEA is approaching its final prototype release scheduled for November of 1999. We will be performing final usability testing to measure SEA’s productivity impacts after the release. *Even prior to this final report, SEA has already had several documented successes:*

?? We have shown how a visual target tuner can substantially reduce the time necessary to layout specific exposures.

?? SEA has already demonstrated the value of simple visualization tools, and the extensible framework (we have multiple instruments using the same core class libraries).

?? STScI has already chosen to adapt the Visual Target Tuner and the Exposure Time Calculator into its operational tool suite.

?? We have demonstrated the feasibility of Java as a true multi-platform development environment.

We are looking past these accomplishments towards the next major jump in observing proposal preparation tools: to be able to interactively model and display observing parameters.

3.2 General System Criteria

There are several high-level requirements that an observing tool must have. Many of these have already been implemented into the SEA prototype. We will continue to develop our new visual, interactive components with these requirements in mind:

?? User orientation - All components of the system should use terms and concepts that are meaningful to astronomers. Tools must be friendly and intuitive at first glance.

?? Responsiveness and speed - Whenever possible, results of user actions should be available immediately. Visual updates to changes should be displayed instantaneously. This responsiveness will reduce user frustration associated with batch processing. It will also allow the user to make scientific trade-offs in a timely manner.

?? Scientific feedback - The system should provide information needed to make scientific trade-offs. The impact of a choice should be shown in a meaningful way, allowing users to be self-sufficient.

?? Uniformity - All tools should use consistent terminology and have a similar "look and feel" to reduce the learning curve. The same user interface standards that are widely used in general purpose software and other tools used by the astronomical community should be adopted.

?? Interoperability - Tools should be able to share information, alleviating users from having to manually enter and re-enter data and re-process information.

?? Useful documentation - Documentation should be an integral part of the toolset and should be structured to allow efficient access by humans and software tools. Documentation/help should be friendly, up-to-date, and easily accessible to users of varying levels of expertise.

?? Extensible framework – The architecture should be mission-independent and easily specialized for other observatories. Core internal class libraries should be easily adapted as well as standalone visual components.

?? Open architecture - It should be easy for everyone to enhance tools or incorporate fixes. We support the concepts of “Open Source" software paradigm. The core system should be developed to work like a kernel around which the facility can grow following the needs of the community.

?? Capturing expert knowledge - We will explore methods which capture human expertise and make it usable to humans and software. “Wizards" (dialogues that guide users through common tasks) should exist in areas/tasks likely to be requested by average users.

3.3 Features to be Developed

3.3.1 Visualizing the observation

We seek to add to the SEA framework sophisticated tools that will allow astronomers to explore the target/instrument/observatory parameters and to "simulate" the quality of data they will attain. For example, a bright target within (or slightly outside) a field of view can have undesirable effects when observing faint sources. These effects not only depend on the location and brightness of the target but on things such as spectral energy distribution (SED), choice of filters, and exposure times. The simulation will convolve the target properties with the instrument setup, known sources of detector defects, quality of available calibrations, and other observing constraints for a given observing mode. Once the basic model is generated, the user will have the ability to interactively manipulate the various observing parameters to visually determine the impact.

There is a need for several such imaging and spectroscopic simulations for which we propose to develop solutions. While some algorithms/tools have already been developed for performing such simulations, these tools are typically custom built for specific needs and are used by only a limited number of astronomers. Our proposed tools will be able to simulate a wide range of observing parameters and modes, therefore the tools will be useful to a larger segment of the community.

For displaying the simulation, we propose to research visual technologies that are just reaching the average desktop such as real time 3-dimensional rendering, and virtual reality engines. Our goal is not innovation for the sake of innovation, rather we want to evaluate the effectiveness of different visual and interactive approaches, and then focus on further developing those that have the biggest impact to our unique astronomical end-user community.

3.3.2 Expert Systems Applicability

The tools will also be able to assist the user (if desired) in making decisions based on some basic user provided information. To accomplish this, expert system technology will be used to evaluate the observing model and the options available to the observer. Recommendations not only for the observing strategy, but also for optimizing the observation will be given by the tool. As a first step, the software will contain rules on how to avoid common observing problems. It can alert the user and suggest best practices to avoid those problems.

In the prototype SEA, an expert rule base is used in only two small areas: providing recommendations on dithering strategies for imaging programs, and detector/filter selection. In this project, we will explore the following specific areas where we believe this technology will have the biggest impact in the development of observing programs.

?? Smart Help – an improved context sensitive help system that can do more than simply provide help for a specific field or input box. A "Smart Help" would have an underlying rule base that is evaluating the overall context of the developing proposal and provide more information that is specific and relevant to that context.

?? Intelligent and unobtrusive monitoring of the proposal so that helpful suggestions can be obtained on demand. The suggestions and the type of help should adapt to the expertise of the user. This feature is particularly helpful to first time or infrequent observers.

- ?? On demand, the expert system should be able to analyze the current state of the whole proposal, and provide suggestions for optimizing the observing plan. We liken this to final run-through that tax preparation programs like Turbo Tax or Mac-in-Tax provide. The expert system could highlight rough areas or areas that might cause some problems with scheduling, and would ensure that nothing the user specifies can adversely affect the health and safety of the observatory.

The expert system is there to guide the user and to provide “expert” advice when asked. The user will be able to easily bypass or ignore any or all expert system help. The “Turbo Tax” model is a good approach. It provides expert help, without forcing you to use it. Tools with expert systems incorporated in them will save both the observer and observatory staff time, because observers can find help as soon as they need it, and user support can be provided with much fewer staff. The result is more cost effective use of everyone’s time and effort.

3.4 Why the Proposed Tools Would Be Useful

In order to illustrate the advantages of our proposed new approach over the presently available tools, consider the following example. A proposer wants to mosaic a large area of the sky such as a cluster of galaxies using HST's Wide Field Camera (WFPC2).

With current tools such as those available at HST, there are a number of inefficiencies, for both the proposer and observatory staff, which can be either eliminated or reduced with the modern tools and a unifying environment we propose to develop.

Using Current Tools

Currently a proposer must:

- ?? Write his/her own code to determine how the WFPC2 L-shape can be used to tile a region of the sky.
- ?? Guess a possible orientation for the observations. Based on this orientation, specify coordinates (targets or POS TARGs) for each position of the mosaic. These must be entered manually into the Phase II proposal form.
- ?? Complete the rest of the Phase II form. For each position of the mosaic, separate visits/exposures have to be defined by hand, despite the fact that the same observation sequence is requested for each target position.
- ?? Submit their proposed Phase II program.

Next an iterative review occurs. The observatory staff reviews the program for technical feasibility and instrument health and safety. Each time either a technical or an instrument-related problem is identified, the proposal must be re-worked by the proposer and/or the observatory staff, and another iteration of reviews is conducted. This cycle continues until all the observatory constraints are met. Despite all these iterations and checks, the observation may still not completely cover the intended sky area or other unforeseen problems may occur.

The Same Challenge with Our New Environment

The proposer uses the Visual Target Tuner to display an image of the area of the sky of interest. This may be an image from the Digitized Sky Survey or an image provided by the observer. The proposer then identifies the area to be covered in a mosaic of observations.

The software evaluates the area and provides a range of orientations that obey observing constraints and avoid detector defects and possible artifacts. In addition, the system recommends the most efficient orientation and overlays the recommended mosaicing pattern on the image. Either the proposer accepts the software recommendation, or he or she interactively generates different custom mosaic patterns. The user then asks the system to predict the schedulability of the mosaic. When satisfied, the target/aperture positions, available guide stars, and other relevant information that supports the scientific decision are recorded in the proposal without manual re-entry. The proposer completes the rest of the Phase II proposal and submits it. The required exposure parameters have to be listed once, and then they are replicated for the entire mosaic pattern.

No further observatory staff interaction is required, and observations can confidently be executed with a high confidence for success. Since the software has already ensured that the program is feasible, optimized, and that the health and safety of the instrument is protected, the staff can approve the program with minimal additional work.

3.5 Development Approach

We will perform the software design and development process by using accepted object-oriented design and development techniques. This will be an iterative process whereby we will develop our tool suite through a series of roughly quarterly software "builds." Since we will be researching the effectiveness of state-of-the-art visual interfaces and rule-based technology, this iterative approach will allow us to identify and eliminate unsuccessful approaches early, and quickly re-focus on different and more promising approaches. Additional problems in areas such as performance and usability can be identified early and resolved in subsequent design and development iterations. We will continue to develop primarily in the Java language, as it proved itself during the SEA prototype to be a powerful, multi-platform environment.

3.5.1 Performing Initial Design

The first phase of this project will be to develop an initial design. During this one-month phase, we will focus on reviewing the latest state of tools and software and establishing a more detailed road map on how to accomplish our goals. This will involve a review of all options and tools available to us, plus a review of the architectural changes needed in SEA to support the new features. We will complete this phase by documenting our approach in a Design Document to be reviewed with by both STScI and Goddard management and our "Lead Users" (described in section 3.6 below).

3.5.2 Using/Adapting Existing Technologies

A key objective of our system is to utilize software re-use where possible, and to integrate existing software over creating new software. We anticipate looking in two distinct and important directions for sources of tools.

First, we will look within the existing set of tools available to the astronomical community. A large collection of tools already exist that can both help speed our development and provide us with a wealth of robust, adaptable software algorithms. Packages such as IRAF and the STScI's STSDAS, and ESO's JSky provide existing implementations of many astronomical and image processing algorithms. Some of these tools are platform-dependent and will require an interface. In other cases, we may find it most suitable to make use of existing algorithms but converting the actual code to Java. Other tools/utilities are already developed in Java and can be integrated easily.

Second, we will look at the domain of image processing tools. Many advanced visualization tools and techniques have existed for some time, but were only available in very expensive, high-end, graphical workstations. Advances in recent years in both display capability and processing power for the more common desktop systems now make many of these capabilities feasible in systems available to a typical proposing astronomer. In addition to formerly high-end software, new technologies such as Java's Advanced Imaging API (Application Programming Interface), 2D and 3D graphics capabilities, and standards such as VRML (Virtual Reality Modeling Language) are making a completely new range of visualization possibilities available to the average user.

We will evaluate and plan how to best utilize these capabilities before we are committed to a specific approach.

3.5.3 Supporting an Observatory-Adaptable Architecture

We have established relationships with collaborative partners at several observatories in order to help us achieve our objective of developing software that is easily adapted to different observatories. Our colleagues at the Gemini Observatories, European Southern Observatory, and University of Texas' Hobby-Eberly Observatory will help us identify how best to represent observatory specific parameters to make it easy for this system to be used at multiple observatories.

This work will be an extension of relationships begun at the "Workshop on Observing Tools" hosted by the SEA team in October of 1998. Although software reuse has been discussed for many years, in practice it has not been effective. To understand the barriers involved we sponsored the workshop in 1998 (http://aaaprod.gsfc.nasa.gov/workshop). At this meeting, we determined that to achieve the goal of inter-observatory coordination/common interfaces, we first needed to form a common library of re-usable subcomponents that each observatory will use as needed.

By reusing software components across observatories, there is another major benefit to the astronomical community – it decreases the amount of effort needed to learn how to use the observatory and the corresponding increase in the amount of time left to concentrate on the science. For example, in the proposal selection process, many observatories have adopted a LaTeX-based approach (e.g. STScI, Kitt Peak, Cerro Tololo, European Southern Observatory, see Reference 1), this has led to a reduction in Phase I proposing effort for observers at these observatories.

3.5.4 Iterative Development Cycles

Following the design phase, we'll begin an iterative cycle that fits naturally with object-oriented design and development. In each cycle, we will start by evaluating the status and success of the previous build cycle. We will review and possibly adjust the development priorities to focus work for the next build on the successful approaches of the previous build. Following this evaluation, development for the next build will begin. Near the end of each cycle, we will focus heavily on integration and reliability testing and documentation. Once this is complete, we'll issue a Release Build that can be evaluated and reviewed by NASA management and the public. We then begin the cycle again.

This approach is a continuation of the process we have successfully used in the initial development of the SEA prototype. The iterative cycle provides needed design and planning to assure progress, while also giving the team the flexibility to adjust priorities to pursue the most promising developments. It also gives our Lead Users an opportunity to see the progress being made and to provide effective input that can be easily integrated into the process.

3.6 Evaluation and Testing

An important aspect of our proposed effort is the involvement of scientists - from the beginning - in the use and evaluation of the SEA. We feel these tools can and should be used and tested as early as possible. To accomplish this we will solicit the involvement of scientists (Lead Users) who will use the prototype versions of the tools and utilities and provide criticisms for further development. From our experience with SEA, we know that even the initial prototypes will be sufficiently powerful to pay back the Lead Users for their investment of time. Although PI Dr. Koratkar is an active research astronomer, we recognize that it is critical for the software to effectively support a variety of users. It is important to us to have independent astronomical input from users who can provide unbiased evaluations as well as increase the breadth of knowledge contributing to this project.

Our Lead Users will include both astronomers and computer scientists involved in observatory operations. We have already contacted Phil Puxley and Kim Gillies (Gemini 8-m Telescopes Project), Niall Gaffney (Hobby Eberly Telescope), and Miguel Albrecht (ESO/VLT) who have agreed to assist us with this project. These Observatory Lead Users will not only evaluate the prototypes, but also evaluate the design concepts, as they are familiar with providing user support at their respective observatories. Their input will be an important factor enabling us to build an observatory independent approach from the beginning.

We plan to identify the astronomer Lead Users during the initial phase of the project. The team's location in the Washington, DC area is near Goddard, STScI, and universities such as Maryland and Johns Hopkins that have excellent astronomy programs. This will ensure a large pool of astronomers with whom we can work.

Detailed criteria for the evaluation of the tools will be established as part of the project, with the Lead Users playing a major role in defining the evaluation criteria. At this time, we can define some general criteria: Do the tools generate a correct plan for the observing program? Is the prepared proposal error free (using HST as the test bed)? How much time and effort has the user saved? How easy are the tools to use? How extensible are they? How easy is it to adapt the software to another observatory?

4 Relevance to NASA's Mission and Programs

This project applies directly and specifically to the goals of NASA's Space Science Enterprise and to the goals of the Applied Information System Research program.

From NASA's Mission Statement: "To research, develop, verify, and transfer advanced aeronautics, space, and related technologies." (See Reference 2)

- This project will research and develop major innovations in the state of the art of observing tools. It will facilitate the transfer of this knowledge by enabling multi-observatory use of the tools and promoting reuse.

From the Space Science Enterprise Strategic Mission: "Develop and utilize revolutionary technologies for missions impossible in prior decades – a goal recognizing the enabling character of technology" (see Reference 3)

- Observing tools are slowly moving from text-based, manual and repetitive data entry towards a visual approach to establish target locations, we are proposing to radically change how astronomers plan their observations: by giving them the ability to visualize their potential image, and see the impact of changes in observational parameters, *before* rather than *after* consuming real, scarce observing resources.

From the ROSS NRA 99-OSS-01 Research Announcement: "The specific goals of the AISR program are to: "Increase the scientific return on research within all OSS science themes by making advanced tools and capabilities available for the acquisition and utilization of science data and information; Exploit advances in computer science and information technology for the benefit of space science; and Promote strong collaborations involving the space science community, computer science community, data system engineers and technologists, academia, and the private sector and technology innovators." (See Reference 4)

- The core goals and drivers for our proposed project match these AISR goals one-to-one. We are developing tools that are essential to obtaining high quality data, which is a basic requirement for cutting edge science research.

5 Plan of Work

As described above we will use an iterative object-oriented design and development approach. Following the initial design phase we will pursue an iterative build cycle as described above, with builds released on a roughly quarterly basis. Every other build will be a more formal release including documentation as a milestone deliverable.

Twice during the project, once at about the project mid-point and again near the end of the project, we will perform a thorough usability and productivity testing to evaluate progress towards our overall goal of providing a major increase in scientific return for the level of effort by both observing scientists and observatory support staff.

Finally, we propose to use major conferences (SPIE, ADASS) as a focal point for presenting and publicizing our progress to date and obtaining feedback from a wider audience of scientists.

5.1 Milestones

Figure 3 shows our projected schedule and milestones, assuming a March 1, 2000 start date. The software and documentation resulting from each build will be made available to the research community at no cost. We will maintain a project web site on the WWW server at the STScI (http://www.stsci.edu/) and possibly other mirror sites as appropriate.

At the end of the project, we will include on the web site electronic copies of the final documentation including operations manuals, installation instructions, programmer's manual, and test data. Our primary documentation emphasis will be on built-in online documentation and self-installing software as opposed to extensive paper-based manuals. We will also register all successful products and capabilities resulting from this project through the Space Science Data Services (SSDS) infrastructure. If requested, software can also be delivered in any standard form specified by NASA. Software will be delivered in machine-independent Java-based software. While we will test each software release on both Windows and Unix platforms, it should also run without modification on any system that has a current release of the Java Virtual Machine installed.

The results of this project will be published in the astronomical literature, including conference proceedings such as the yearly Astronomical Data Analysis and Software Systems (ADASS) conference as well as topical conferences. In particular, we plan to make presentations and demonstrations at the conferences shown in Table 1. These specific conferences will attract participants with the greatest interest in our work.

Figure 3 Project Tasks and Milestones

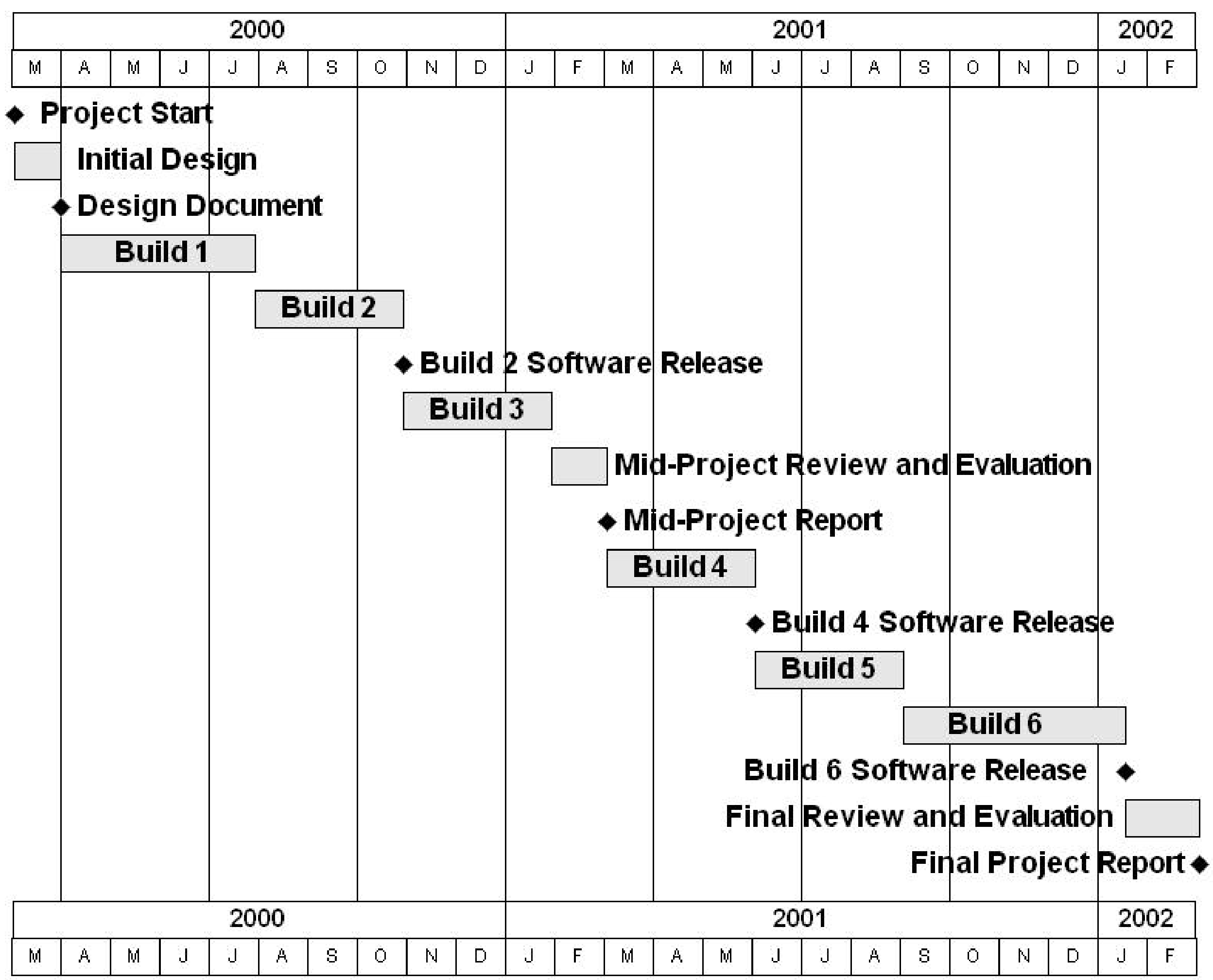


Table 1, Targeted Conferences

Date	Conference	Objectives
November, 2000	Astronomical Data Analysis Software & Systems X, Boston, Massachusetts	Build 2 Accomplishments and Feedback
October, 2001	Astronomical Data Analysis Software & Systems XI	Build 4 Accomplishments and Feedback.
March, 2002	International Society for Optical Engineering (SPIE) Conference on Astronomical Telescopes and Instrumentation	Final Project Accomplishments

5.2 Management Structure

Dr. Anuradha Koratkar, the Principal Investigator, will perform the direct management of this grant. Mr. Jeremy Jones will be the principal system architect and developer. Along with Mr. Jones, Ms. Sandy Grosvenor and Mr. Mark Fishman will be responsible for the software development effort. All team members will be working closely with daily contact on this project. They bring extensive, proven track records in the management and development of SEA, and other software tools for other NASA missions to this project.

A strategic goal of the Space Telescope Science Institute is to bring the tools and experiences of the HST project to other NASA missions and observatories. The "Ideas to Observations: User Support Tools for the Next Decade" opportunity will be viewed with great interest and importance by senior management at the STScI. In addition to providing an experienced infrastructure for the financial management and deliverables tracking, routine progress reports will be delivered to STScI senior management via monthly reviews.

Starting with the first electronic observing proposal system in 1986, the STScI has used these design, development and management techniques to successfully develop and deliver an extensive suite of science and operational tools to users of HST. The STScI and GSFC have the proven ability to develop and deploy software to the astronomical community with a framework that makes technical advancements and new frontiers the norm for our development projects.

6 Contributions of the Team Members

The STScI has several highly talented software development groups that are a valuable resource to this project. Groups within STScI such as the Presto Software Support Team, Planning and Scheduling Development Team, and research scientists will be consulted frequently on issues such as evaluating new technologies or gaining practical experience with tools.

STScI and GSFC offer a unique opportunity to implement the concepts in this proposal. Our work on both prototype systems and operational software systems demonstrates our ability to produce working software (not just "vaporware"). The investigators for this proposal are particularly qualified to lead this project due to our experience in both astronomy and software development. Our interaction with the astronomical user community will allow us to survey the needs of many different users both space and ground based. The general nature of our concepts and its independence of any particular observation scheduling system, spectral region, and telescope design are important design features.

Most of the members on this team were primary developers for the development of the SEA prototype. Many of these prototypes will be operational tools for the scientific community by spring 2000. Our team also includes a number of members who have been instrumental in the development of proposal preparation systems (RPS2), and data visualization and access tools (JSky tools).

Specifically, as the Principal Investigator, Dr. Koratkar will provide the leading scientific direction for the project as well as overall management. Dr. Koratkar's background as both an active research astronomer and as a key member of STScI's user support staff gives her a unique perspective and blend of experiences. She was also the lead scientist on the SEA prototype team.

Ms. Grosvenor is the lead author of the Exposure Time Calculator component of the SEA prototype. She has strong background both in object-oriented programming and in end-user applications development and Java-based rule-based applications.

Mr. Fishman is the lead author of the Visit and Orbit Planning Modules of the SEA prototype. He also has a strong background in object-oriented programming and will have primary responsibility for the design and development of observatory modeling.

Mr. Jones has been the Goddard Team Leader for the SEA prototype and is the lead author of its Visual Target Tuner. He will continue to provide his expertise in visualization tools and techniques.

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2) “1998 NASA Strategic Plan with 1999 Interim Adjustments”, National Aeronautics and Space Administration, 1999. (Available electronically at: “http://www.hq.nasa.gov/office/codez/plans/NSP99.pdf”), page 8

3) “1998 NASA Strategic Plan with 1999 Interim Adjustments,” page 18.

4) Research Opportunities in Space Science – 1999, National Aeronautics and Space Administration, 1999. (Available electronically at: “http://spacescience.nasa.gov/nra/99-oss-01/”), Section A.5.2.